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Chapter 18

Amino acid: the amino acid is a carboxylic acid that contains an amino group in the same molecule.

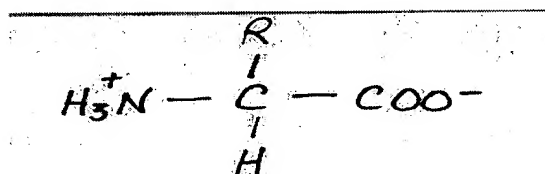
The carbon in the middle is referred to as the **alpha carbon**. Attached to the alpha carbon are 4 groups: a carboxylic acid (COOH), an amine (NH₂), a hydrogen (H) and a side-chain (R).



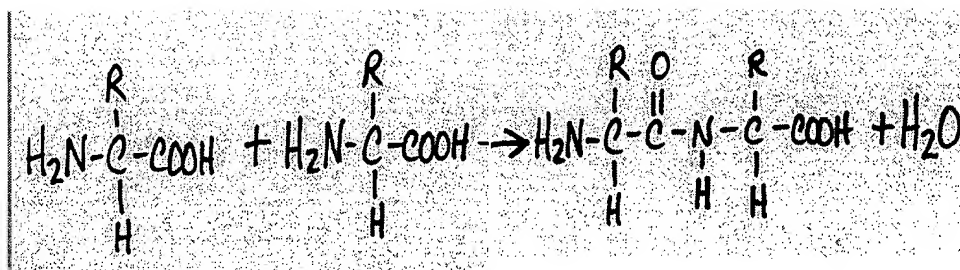
The amino acids are classified into groups according to what kind of sidechains they have.

Amino acids also have stereoisomers (except for glycine). Most amino acids in nature are L-form.

Zwitterions: Because the amine group and the carboxylic group are so close to one another, they can transfer a hydrogen. In this case, the amine would end up positively charged and the carboxylic acid would have a negative charge.



Peptides: Peptides are combinations of amino acids. The amino group of one acid forms a **peptide bond** (an amide bond) with the carboxylic group of another acid. Peptide bonds are always formed from the alpha amine and the alpha acid. . . never from the side chains. The amino acids in the peptide are called **residues**.



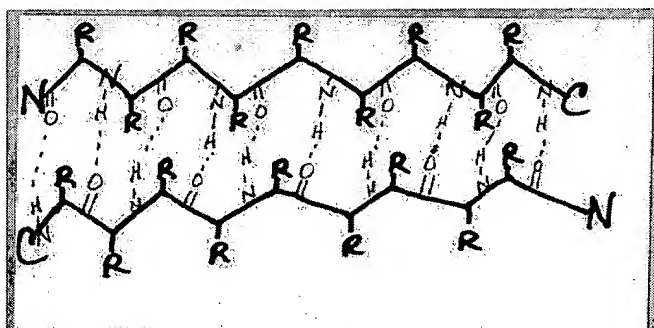
The peptide has one end that is called the **N-terminus** (the end with the free amino group) and one end that is the **C-terminus** (the end with the free carboxylic group). Prefixes like di-, tri-, and tetra- will indicate how many residues are in a peptide. A peptide with more than 20 residues is a **polypeptide**.

When you name a peptide, start from the left with the N-terminal residue. The three letter abbreviations are used most often.

Disulfide bridges: when a peptide or protein has two cysteine residues, or when a peptide with a cysteine residue is next to another one with a cysteine residue, a disulfide bond (S-S) can form between the -SH groups of each cysteine. The disulfide bridges effect the shape of the molecule. The bridge pulls the chain into loops, or hold two peptide chains together. Disulfide bridges also affect the properties of proteins.

Proteins: Naturally occurring peptide with more than 40 amino acid residues. The structure of proteins is organized on four levels.

- **Primary Structure:** This relates the order of the amino acid residues in the chain. Primary structure also includes any disulfide bonds.
- **Secondary Structure:** Specific regular repeating patterns of folding. Secondary structure is mostly due to hydrogen bonding. Two shapes in particular have been covered in class:
 - **Alpha Helix:** Right handed corkscrew shape. 3.6 amino acid residues per turn. H bonds exist between O on upper turn and H-N on the lower.
 - **Beta Pleated Sheet:** Zigzag peptide backbones arranged side by side, and held in place by H bonds between the peptide chains. Each zigzagging chain runs in opposite directions.



- **Tertiary Structure:** The overall 3-D shape shape of a protein.
- **Quarternary Structure:** The arrangement of multiple segments (subunits) makes up the

quarternary Structure.

There are 4 types of interactions that effect tertiary and quarternary structure.

- **Hydrophobic Effect:** Hydrophobic side chains tend to orient themselves in the protein interior so that they will be away from the water outside. (Ala, Val, Ile, Leu, and Phe are all hydrophobic side chain containing amino acids.)
- **Hydrogen Bonds:** Mostly between the peptide linkages (the amide bonds).
- **Disulfide Bridges** These are the only covalent cross linkages.
- **Salt Bridges:** + and - charges in adjacent ionized sidechains attract one another.

Prosthetic groups: A nonprotein portion of a protein. The prosthetic group of myoglobin and hemoglobin is **heme**. Heme contains an iron (II) ion.

- Both hemoglobin and myoglobin are important biologically. **Myoglobin** is a protein found in muscle tissue of mammals, and enables the body to store oxygen until it is needed.
- **Hemoglobin** is a protein found in red blood cells. Hemoglobin has quarternary structure: the hemoglobin molecule has 4 subunits which each contain a heme prosthetic group. Specifically, the Fe in the heme forms complexes with oxygen, allowing the red blood cells to transport oxygen to the body's tissues. The Fe can also form complexes with other molecules, such as (CO) and (CO₂). This is what makes carbon monoxide so dangerous. It's affinity to hemoglobin is about 200 times stronger than oxygen's.

Diseases Related to Defective Proteins:

- **Sickle cell anemia:** defect occurs in beta chains only. The mutation of a single amino acid causes a major disease. The hemoglobin in sickle cell is less soluble than normal hemoglobin, causes the hemoglobin to precipitate out of the red blood cells.
- **Methomoglobinemia:** the iron (II) in hemoglobin is oxidized to iron (III). It can not bind to oxygen this way.

Denaturation: occurs when a protein unfolds. It changes the protein from the functional form to an unfunctional form. The protein unfolds because of the breaking of H bonds or disulfide bonds. Denaturation effects the secondary, tertiary and quarternary structure of the protein, but does not change the primary structure. It may or may not be reversible.



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